Cross Layer Techniques for Mobility Management in Wireless Mesh Networks: A Survey

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Abstract— Wireless mesh networks (WMNs) play significant role in an economic way to support large-scale wireless Internet access through multihop wireless communication links. Efficient mobility management techniques enhancing the performance of wireless mesh networks is an important component of realizing large-scale WMNs. Mobility management solutions that has implemented in cellular and Mobile IP network can cause significant performance degradation when directly applied to WMNs. In this paper we have investigated the various mobility management schemes for IP based hybrid WMNs. These schemes are broadly classified as tunnel based, routing based and multicast based solutions. The motivation for mobility management is discussed and existing work in mobility management is surveyed.

Keywords—cross layer, Handoff, Mobility Management Schemes, WMN

I. INTRODUCTION

Wireless mesh network (WMN) are multihop wireless networks in which each node communicate directly or indirectly with the peer. The multihop feature increases the coverage area and the link robustness when the communicating nodes are not in the transmission range of each other[1, 3]. A WMN is dynamically self-organized, self-configured and self healing network with the nodes in the network which can automatically establish and maintain the mesh connectivity. The WMN may be connected to the internet through the gateway/routers and to other networks through gateways/bridges.

The architecture of the WMNs can be categorized based on the topology which includes flat and hierarchical. Based on the technology we have homogeneous and heterogeneous WMNs and on node based we have deployment configuration, WMNs can be broadly categorized into three main types: infrastructure/backbone WMNs, client WMNs and hybrid WMNs. A WMN has two types of nodes Mesh Routers and Mesh Clients. The mesh router has additional routing functions to support mesh networking. A mesh router has minimal mobility and the clients can be mobile or static. Fig. 1 shows the traditional architecture of WMN.

Mobility management consists of two parts[2]. Location management and handoff management. Location management involves two stages that enable the network to find the current attachment of the mobile user to carry out the call delivery. The first stage is the location registration in which the mobile terminal periodically notifies the network with it new access point. The second stage is the call delivery in this involves the database queries and paging to find the current position of the mobile host. Handoff management enables the network to maintain user’s connection as the mobile client moves across and its attachment point changes in the network. The handoff management involves three stages namely the initiation, new connection generation and data-flow control.

Mobility management techniques in networks such as cellular IP and mobile IP [2] [27] cannot be applied to the WMNs as the signaling messages related to mobility travels on wired infrastructure[26]. In case of WMNs it deals with wireless multihop route discovery and providing seamless communication with minimal packet loss and low latency is challenge in mobility in WMNs due to the mobile client and its inherent features such as wireless connections and multihop.

In this paper, we discuss on the mobility management design in WMNs. Section 2 gives the motivation for mobility management in WMNs and section 3 gives the survey of the existing work on different mobility management schemes in WMN.
II. MOTIVATION

Wireless mesh networks are becoming one of the popular communication media due to its self organized, self-configured and self healing features. Mobility is very crucial in WMNs for uninterrupted service delivery. The traditional mobility management schemes of like cellular and mobile IP networks[4] cannot be directly extended to WMNs. The signaling traffic is transferred on the wired path[27], whereas in WMNs use the wireless multihop paths for mobility support. Wireless channel access, re-routing, route maintenance among the wireless multihop paths add to the increase of handoff delay, failure rate of location update and paging. Keeping the handoff delay to minimum is a challenge to seamless communication. Extensive research has been done on routing and medium access control to increase the data throughput. These add additional signaling message which will compete with the resources required by the signaling messages of mobility management. This affects the performance of WMNs.

The traditional mobility schemes of cellular networks consider the hierarchical structure of networks and there are dedicated location servers like HLR/VLR to update the location of mobile clients. In case of WMNs the network structure is usually flat and there is no concept of central location database. All these factors make that the existing mobility management schemes which cannot be applied directly to WMNs. IP address resolution, location management and media access control [18] are the main important factors to be considered to achieve seamless mobility.

Mobility brings significant impacts on each layer. It has been mentioned in [5] that cross layer design is highly desired if optimum network performance must be achieved. Hence a mobility management with cross layer signaling methods is very crucial. Different cross layer signaling methods [6] are discussed here like the packet headers, ICMP messages, local profiles and network service. Co-ordination between layers provides fast and seamless handoff. A cross layer handoff management protocol is discussed in [7]. From the link layer the speed and from the network layer the handoff signaling delay is used in this protocol in order to decide when to initiate and execute the handoff. By using link layer information such as the signal strength the handoff latency can be reduced[37, 38].

III. RELATED WORK ON MOBILITY MANAGEMENT

Significant work on the survey of mobility management in wireless networks is mentioned in [2, 4]. Seamless mobility has to be achieved to meet the real time application constraints. Due to the wireless multihop nature of wireless mesh networks the available conventional mobility management techniques cannot be directly applied to wireless mesh networks. Also by designing new techniques considering the information from different layers for mobility management, performance of the network can be significantly improved. In this section some of the existing work on mobility management for WMNs are discussed.

A. Tunnel Based Solutions:

I. Ant Mobility Management Scheme

Ant [8] is a network based intra domain mobility management scheme proposed for infrastructure wireless mesh networks. When a mobile host (MH) joins the mesh network, it performs the MAC layer association with access router in the network to which it is attaching. By this process the access router will come to know the MH-ID, the MAC address of the mobile host’s network interface. The access router sends the location update message to the location server present in the mesh network domain. The location server is a location database which has the location information of all the mobile hosts. The entry in the database has 3 mappings {MH-ID, MH-IP, and MH-AP}. MH-IP is the IP address of the mobile host. MH-AP (Access Point/Access Router) is the IP address of the access router to which the mobile host is currently attaching. If an entry exists in the location data base the location server updates the data base else it requests the DHCP server to allocate new IP to the mobile host MH-IP. This is sent back to the MH via the DHCP protocol. There exits one default gateway router which connects to the internet.

Communication between the mobile host and correspondent node (CN) is done by establishing bi-directional tunnel between them. Mobile host issues ARP Request message to get the MAC address of the CN. On receiving this message the access router of the MH queries the location server to get attaching router of the CN. The MH-AP will talk to CN-AP to set up a bi-directional tunnel between them and add a route entry to forward packets for the MH and CN.

Handover is assisted by the neighbor access router information present in the mesh routers. This information is built by broadcasting the one or two hop neighbor solicit message. The replies for this message are used to build the neighbor list in the access router. Below are the steps for handover and fig 2 depicts the handover.

i. Upon MAC-layer de-association event, the old AP starts to buffer packets destined to the MH and sends a handover notification message to all the APs in its neighbour list.

ii. When the new AP captures the MAC-layer association or re-association event of the MH-ID, it checks if it has received the handover notification message.

iii. If so the new AP sends and handoff confirm message to the old AP and location update message to the location server.

iv. Once the handover confirm message is received old AP stops buffering and a bidirectional tunnel is setup between the old AH and new AH to send the buffered and later coming packets.

v. The old AP informs AP-CN to route the packets to new AP

vi. And also inform new AP route the packets destined to the CN to be sent directly to AP-CN.
Advantages are ANT uses MAC layer event to trigger handoff. This is more accurate and consumes less bandwidth. The mobile host keeps its address unchanged and hence it is not required to reconfigure the IP stack.

The main cost involved is updating the location information immediately in the handoff process and setting up the tunnels in advance to decrease the delay in establishing the temporary tunnel.

II. Mesh Mobility Management (M3) Scheme

The mesh mobility management (M3) scheme[14] uses the hybrid routing approach i.e., the tunneling and mobile-specific routing strategies to support mobility in infrastructure mesh networks. This reduces the signaling cost and reduces the handoff latency.

Fig 3: Mesh model of M3 scheme

M3 scheme uses a tree structure with one gateway and the routers below it has the superior status. The remaining nodes below them have same status. The gateway is responsible of assigning the IP address to the mobile client. Mobile IP can be used when inter-domain roaming is desired and the assigned address id used as CoA. The gateway is required to assign a unique IP address in its domain to a mobile client when it is powered.

The gateway records the location information after performing the AAA procedures. Each AP (Access Point) has the database of subscriber information of the clients in its cell. The superior routers has the location information of all the clients of its subordinate APs cells owned by.

The downstream packets are handled using the tunneling techniques indicated by the red line in fig 3.

The tunnels are used from the gateway to the AP serving the mobile client. The serving AP decapsulates and forwards them to the addressed mobile clients in the cells. For the upstream packets, the APs use the default routes to forward packets to the gateway.

For the handoff, on receiving the handoff request from the mobile client the new AP sends a handoff request message to the former AP. The former AP sends the required subscriber information the new AP and adds a temporary route entry to the mobile client’s destination address. When the downstream packets are decapsulated at the former AP and find that the mobile client is not present in its cell, it forwards to the new AP using the temporary route entry. As the client moves on, there exists a path from each of the former AP to the new AP. Thus there is chain a pointers. As this introduces the triangular routing problem, periodic location update is done. In this once every particular time interval, the AP reports all the clients info under them to the superior router. The superior route selects another period of time after which it updates the gateway. By this the packets can be directly tunneled to the AP serving the mobile client, rather than traversing all the APs the mobile client had visited.

The advantages are as the hierarchical structure is used the delay in getting the mobile clients location information is reduced. Scalability is increased. But there is overhead of encapsulation and de-capsulation.

III. iMesh Mobility Management Scheme

iMesh (infrastructure Mesh) [9] is a routing based mobility management scheme which uses layer-2 handoff event triggers to do the routing updates in the mesh network. This is a cross-layer mobility management scheme involving layer-2 and layer-3. This scheme uses flat routing protocol to maintain optimal routes to all the mobile clients. The layer-3 handoff trigger causes the routing updates and propagation of the same in the mesh network [20]. Every AR in the mesh network has a routing table containing the paths to all clients.

Whenever a mobile client gets associated with an AP, it is assigned an IP address via the DHCP from the address pool of this AP. The associated AP maintains a mapping of the IP address to the MAC address of the mobile client in IP-to-MAC address mapping table. The AP adds host specific route to this mobile client and now the mobile has uplink connectivity. The AP then advertises the new route to the mobile client to all other APs in the mesh network using the OLSR protocol via
the link state update. After this downlink connectivity to the mobile client is established.

Layer-2 handoff is triggered when a mobile client moves out of range of the AP. Using the probe request and probe response the mobile client associates with the new AP depending on the best signal to noise ratio. After this follows the authentication and re-association procedures to exchange information such as transmission rate etc. At this stage the layer-2 handoff completes. As for the network layer routing is considered a flat routing protocol is followed. The routing table in all the APs contains the IP addresses of all the mobile clients in the network.

By using the flat routing approach, the triangular routing problem which exists is Mobile IP or TMIP is overcome. But there exists overhead which results from routing table updates after handoff. This increases with the increase in the number of mesh clients and limits the scalability.

IV. MEMO (MEsh networks with MObility Management ) Scheme

In MEMO (MEsh networks with MObility management) [11] the mesh routers are self configurable. The network administrator assigns a unique ID to the mesh router. The DHCP process which runs on the mesh routers are in charge of allocation IP address to the mobile clients. MEMO uses a simple hash functions to derive the IP address in which the first 8 bits of the IP address is 10 and the remaining 24 bits is of the MAC address. Whenever a mobile node joins the network Local Registration procedure is initiated. During this the mobile node sends an association or reassociation frame (when the mobile node roams to the new mesh router) to the mesh router. The mesh router stores the mobile node information in the data structure called the Local MNs Table. This table stores the mac and the ip address of the MN. The IP address is calculated using the hash function mentioned above.

Routing in MEMO:

The routing used here is the modified AODV called AODV-MEMO. AODV-MEMO has two modules namely ARP spoofing module and Packet relay module. When a mobile wants to communicate with the destination mobile node, it sends an ARP request to get the destination mobile node’s MAC address. The local mesh router on receiving the ARP request replies with a fake MAC address which acts as an agent on behalf of the destination node. In the Packet Relay module a data structure module called the Route Table is maintained. This packet relay module interacts with the Local Registration module. The local registration module when it update the Local MNs Table it adds a self route entry to the Route Table containing the IP address of the new mobile node. This is used by the packet relay module to know if a mobile node is associated with the mesh router.

In case of traffic between two nodes involving the same mesh router, the router relays all the data packets to the destination node. In the case of two mobile nodes associated with different node wants to communicate the following steps are executed:

- The source node send ARP request to get the MAC address of the destination node.
- The mesh router associated with the source node sends fake MAC address on behalf of the destination node. The source node then sends the data packets to the mesh router.
- The packet relay module in the mesh router does not have entry for the destination node. It initiates AODV route discovery.
- Remote mesh router has self route entry to the destination mobile node and replies with route reply to the mesh router at the source node and thus a bidirectional route is built between the two mesh routers and the communication between the source mobile node and destination node starts.

MEMO adopts a cross-layer mobility management solution i.e., it uses MAC-layer trigger Mobility Management. Consider the case when the destination mobile node roams to a different mesh router

- The destination mobile node sends DISASSOCIATION frame to the original mesh router. The original mesh router deletes the mobile node entry from its Local MNs Table. The destination mesh router floods Route Err message so that source mesh router updates its Route tables.
- Destination mobile node send ASSOCIATION frame to the new destination mesh router. Then the LMT and route table are updated in the new destination mesh router.
- Source mesh router initiates the route discovery and new route from source mobile node to the destination mobile node is established. In case the source mobile node roams to different mesh router, then new mesh router initiates the route discovery.

The advantages of AODV-MEMO are no modification is required on MNs, cross layer interaction between MAC and Routing Layer reduces the handover time.

One drawback is the routing table updates during handoff is a problem and with the increase in the number of mobile nodes, the size of Route Table also increases.

C. Multicast based solution:

V. SMesh Mobility Management Scheme

SMesh [12] is a wireless mesh system which provides seamless, fast handoff 802.11 wireless mesh network that supports fast handoff for Real-time applications. SMesh uses the Spines messaging system in order to establish the communication between the mesh nodes. Logical wireless links are established between the nodes and uses link state protocol is used to exchange the routing information between the nodes.[4,29] Spines provides the multicast(class D IP address) and anycast functionality(class E IP address) Each client in is associated with two groups the multicast data group, the Client Data Group and multicast control group. The internet gateways form a multicast group called the Internet Gateway Multicast Group (IGMG).

The mobile client is assigned a unique IP address by the DHCP server running on the mesh node. DHCP also associate a default gateway to the mesh client such that the mesh client routes the packet through the mesh access node. When a
packet that has to be sent to a mesh client, the packet is sent to the client’s data group and each of the nodes in the data group forwards the packets to the mesh client. A multicast tree is used to forward the packets. The duplicate packets are dropped at the transport level in the client. If the packet has to be sent to the internet the packet is sent to client’s access point to the nearest internet gateway by forwarding it to the anycast group of internet gateways. The internet gateways do the network address translation before forwarding the packets to the internet. Reverse network address translation is done when the packet is destined to the mesh client from the internet before sending the packet to the client data group.

In order to maintain continuous connectivity to the client, the client is monitored using the ARP requests. The node in the client data group periodically send the request and the nodes nearby use the reply to check the connectivity. The intra-domain mobility management in SMesh networks is as follows. As said earlier a client has client data group associated with it. A mesh node that has the best connectivity to that client joins the client data group. In addition this client data group, the access points around the client joins a different multicast group called the client control group. This is used to co-ordinate with other mesh nodes around the client regarding the link quality metrics and who is best to serve the client. When a node is able to serve the client at its best it sends the gratuitous ARP as a unicast to the client. The MAC address of the default gateway is updated. Also it joins the client data multicast group. If there is more than one node in the client data group, packets destined to the client are sent to both of the nodes and both of the send the packets to the client.

By using this multicast client data group there is seamless connectivity. But the there is wastage of bandwidth due to the messages exchanged between the SMesh routers to maintain the Client control group and Client data group.

Multicast routing is also proposed for WMNs as a strategy to reduce the delay and packet loss of handoffs. In SMesh, every mesh client is associated with a multicast group, Client Data Group. All packets sent to a mesh client are forwarded to the Client Data Group, and the router in the Client Data Group then forwards the packets to the client. When handoff occurs, the new AR sends a gratuitous ARP [23] message with its MAC address to the mesh client, and the mesh client maps the new AR’s MAC address to the default gateway IP address. Though the use of multicast groups of ARs ensures seamless handoff, group management is the main cause of overhead. Messages exchanged between ARs in order to maintain the Client Control Group and Client Data Group waste significant amounts of bandwidth.

D. Hybrid Routing Based solution:

VI. Mobility Management Solution based on hybrid routing protocol

This mobility management scheme [10] is based on hybrid routing protocol based on both link layer routing and network layer routing. This solution does not involve the location updates and re-routing after handoff. Packets among the mesh routers and routed using the link layer routing. The access router and the mesh client use the network layer routing. Each mesh router maintains a routing table. Each entry has the destination MAC address and it associated next hop MAC address. This routing table as shown in Table 1 is formed by a proactive or reactive routing method such as the Hybrid Wireless Mesh Protocol.

<table>
<thead>
<tr>
<th>Dest MAC Address</th>
<th>Next Hop Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 15 58 83 DF 96</td>
<td>00 15 58 83 DF 98</td>
</tr>
<tr>
<td>00 15 58 83 DF 76</td>
<td>00 15 58 83 DF 78</td>
</tr>
</tbody>
</table>

A mesh client selects the access router that has best response delay and sends an Association request to the access router. The access routes then obtains a new IP address thru DHCP and returns Association Confirmation message to the mesh client with client’s IP address, access router MAC address and gateway’s MAC address. Each router maintains a table (IP address and MAC address pair) of all the clients registered with it.

In case of communication between two mesh clients, if the source mesh client knows the destination MAC address, source client forwards the packet to the destination access router. When the destination MAC address is not known the client node sends an ARP message to get the destination’s MAC address. The source access router then forwards the packet to the destination access router using the layer 2 routing path and the packet is delivered to the destination client using the destination’s IP address. To send a packet to the mesh client, if the gateway knows the MAC address of the client access router it forwards the packet according to the layer 2 routing table. Else gateway uses ARP message to obtain the MAC address.

Fig 4: Scenario of Intra domain routing

Intra domain mobility (fig 4) involves the following steps. When the mesh client roams in the mesh network the link quality changes. The mesh client selects the access router which has the best response delay.

- The mesh client sends the association request message to the new access router which contains the client’s IP
address and MAC address pair encapsulated.

- When the new AR receives this request, it adds the client’s IP address and MAC address pair to its ARP table.
- The new access router sends back an association confirmation message to the mesh client.
- The mesh client replies to the ARP messages with new AR’s MAC address.
- The source mesh client sends gratuitous ARP (GARP) message to the destination node with the new mesh router’s MAC address.
- The destination maps the new access router’s MAC address to the client’s IP address. The packets now can be forwarded to the MAC address directly.
- The source client sends disassociation message to the old access router with MAC address of the new access router. This can be used to tunnel the packets to the new access router and the tunnel is deleted when the old access router no longer receives the packets for the client.
- If the mesh client is communicating with the internet, then the gratuitous ARP (GARP) message is sent to the gateway.

Inter-domain is triggered when the mesh client moves to a different access router in different domain. Inter-domain mobility involves the following steps.

- After the association request is sent to the new access router, association confirmation is sent to the source client with the new access router’s MAC address and new gateway’s IP address.
- The main difference here is the mesh client gets a new IP address. Mesh client sends disassociation message to the old gateway.
- A tunnel is established between the old gateway and new gateway for packet flow.

E. Other Mobility Management schemes:

VII. Mac Layer Handoff Management Scheme

In the paper [21] they propose an efficient MAC layer handoff scheme for wireless mesh networks. In this paper the delay involved in Layer 2 handoff is minimized. The stages involved in this are discovery, authentication, wireless mesh router selection and re-association with the new mesh router. The discovery delay is reduced by using the handoff prediction information. By using this information the MS will scan only a subset of available channels and hence the discovery to trigger the handoff takes less time. The target WMR is selected using the airtime cost as the metric.

Handoff cache is maintained by each wireless mesh router. This cache has the handoff history which contains the information of wireless mesh routers that have been switched to after disassociating from the current mesh router. This handoff cache is build when a mesh router receives the disassociation request from mobile station. The handoff cache is then sent to the mobile station in the probe response frame. The disassociation request has the information such as the new mesh router the mobile station is switched to and the channel number. During the discovery stage only those channels are probed which are present in the handoff cache and hence the number of channels to be scanned is reduced. If the probe response matches any of the mesh routers present in the cache then waiting for maxChannelTime does not arise.

In the wireless mesh router selection phase, the mobile station calculates the airtime cost (amount of resources consumed to transmit a particular frame on the link) for each of the mesh router. The mobile station selects the wireless mesh router with minimum airtime cost and association is performed with the new mesh router.

Cross-layer design can be considered along with the proposed solution above and with the co-operation of transport, routing and MAC protocols to meet the different QoS and services in the wireless mesh networks.

VIII. Intergateway cross-layer handoffs in wireless mesh networks:

A new design is proposed in [25] for parallel execution of the handoff steps of different layers together with data caching which ensures minimum packet loss.

When the mobile node changes its attachment to the internet through the different gateway as in fig 5 as the subnet changes this involves link layer, network layer and application layer handoffs. Here they propose a cross-layer approach with integrated design of L2, L3 and L5.

As the mobile node moves from one subnet to another it IP address changes and two handoff designs (default and gateway based) are discussed in [23] on to how a mobile node obtains a new address. In default design the mesh router with access point functionality can assign a new care-of-address to the mobile node. Hence each access point is assigned to a particular gateway. After the L2 handoff, the mobile node gets new address through the Agent Advertisement message broadcasted from the new access point. In the gateway based design the gateway is responsible in assigning the care-of-address to mobile nodes. After L2 handoff gateway request...
and gateway reply message are exchanged between the mesh router and the mobile node using the routing protocol of the mesh network. The gateway reply has the care-of-address from this the mobile node can it requires a L3 handoff. In this there is an option of using different gateways for load balancing but the default design has less L3 handoff detection delay.

IMEX [25] proposes a solution to overcome the delays of the default and gateway based handoffs in wireless mesh network. Each mesh router is placed in different groups and this grouping is done during the deployment phase. This makes the address management and L3 handoff detection easier. Special mesh routers called Xcast-based Group routers (XGRs) are used which have multiple IP addresses. Each IP address corresponds to a different subnet, these XGRs connect different subnets and these help in information exchange between the subnets during the inter gateway handoffs. In case of intra gateway handoff the information sharing will be within the group.

A cross layer handoff scheme is proposed in which the channel information and network ID of the candidate access point is obtained from L2 handoff step. From the network ID the XGR which connects the two subnets can be identified and prepare for the L3 and L5 handoff in advance. The XGR prepares the path between the candidate access point and also between the XGR and the gateway through which the mobile node connects to the internet. Also the XGR performs the duplicate address detection. By executing these steps the delays involved in L3 handoff detection, duplicate address detection, discovery of route is eliminated. After the L3 handoff preparation, the XGR notifies the correspondent node the new IP address and the L5 session can use the new IP address. Thus the path discovery delay to continue the session is eliminated.

Also they propose explicit multicast (Xcast) to cache data in the candidate access points to reduce the packet loss during inter gateway handoff. The Xcast data packet is constructed using the IPv6 header’s format. The destination address is eliminated.

TABLE II

<table>
<thead>
<tr>
<th>Layer Routing Address Type</th>
<th>Mobility Overhead</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ant L3 OLSR IP address</td>
<td>Intra</td>
<td>Normal</td>
</tr>
<tr>
<td>MI L3 - IP address</td>
<td>Inter</td>
<td>Normal</td>
</tr>
<tr>
<td>iMesh L2-3 OLSR IP address</td>
<td>Inter</td>
<td>High</td>
</tr>
<tr>
<td>Meme L2-3 Address-memo IP address</td>
<td>Intra</td>
<td>High</td>
</tr>
<tr>
<td>Snoop L3 - MAC address</td>
<td>Intra</td>
<td>High</td>
</tr>
<tr>
<td>Hybrid L2-3 Hybrid routing</td>
<td>Intra</td>
<td>Low</td>
</tr>
</tbody>
</table>

IV. Conclusion

Wireless mesh networks gives high capacity mesh backbone with wireless links providing last few miles connectivity. The mesh routers are power efficient, usually static and WMNs can be easily deployed. As the clients attaching to the mesh network are mobile, mobility management is one of the important aspects in wireless networks. Seamless mobility is the desired feature of WMN to support real-time applications. In this paper we have done a survey of existing mobility management scheme and discussed the advantages and disadvantages involved in them which have been summarized below paragraph.

In ANT though the handoff delay is reduced by deriving the IP address of the client from its MAC address but at the cost of routers implementing non-standard IP routing and the high overhead of updating the routes in the mesh routers. In Imesh the triangular routing problem of MIP is eliminated but the flat routing limits the scalability. Smesh provides seamless handoff but this requires maintenance of multicast groups. Thus by considering some of the existing features and others such as cross layer techniques can greatly enhance the performance of mobility management.

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